

1. Consider the neural network shown in Figure 1. The neurons in the hidden (middle) layer have ReLU activation function.

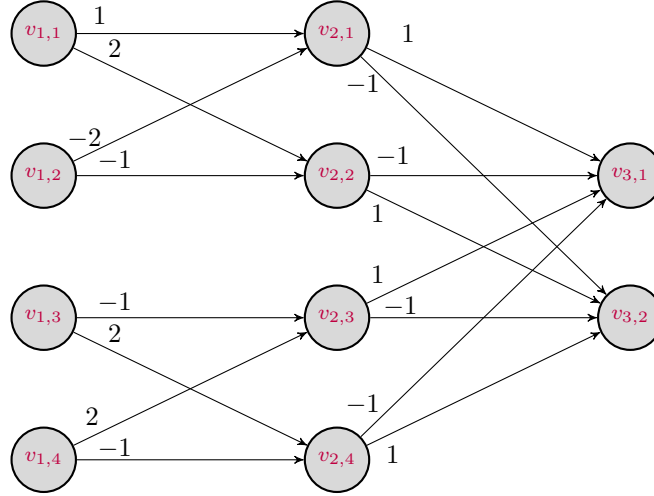


Figure 1: An example

- (a) Find out the value of the output layer neurons for the input $\langle -1, -1, -1, -1 \rangle$.
- (b) Find out if there is another input which is at most $0 \leq \delta \leq 0.3$ away from $\langle -1, -1, -1, -1 \rangle$, in the L_∞ norm (i.e., the absolute value of the difference between corresponding input-neuron values should not be bigger than 0.3), such that the output neuron that was getting the bigger value earlier (for input $\langle -1, -1, -1, -1 \rangle$) now gets a smaller value than the other neuron. Use Z3 to solve this. You can get Z3 from here: <https://github.com/Z3Prover/z3>. It may be quicker to download pre-built Z3 binaries (appropriate for your machine) from here: <https://github.com/Z3Prover/z3/releases>. Submit the input file that you used with Z3.
2. Consider the neural network shown in Figure 2, where the red colored neurons have an activation function which is given by $\text{SpecialReLU}(x) = \max(0, \min(1, x))$. Assume that the inputs neurons can only take the values 0 or 1.

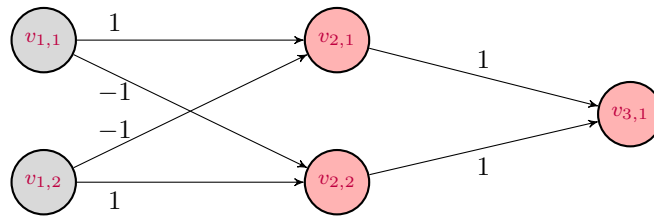


Figure 2: Example with **SpecialReLU** activation

Your task is to find out if it is possible for the output neuron to get any other value apart from 0 or 1. Use Z3 to get an answer; submit the input file that you used with Z3 to get this answer.